AIR QUALITY
ATIKOKAN

ANNUAL REPORT, 1976

[redacted]

Ontario

Ministry
of the
Environment

L. F. Pitura
Director
Northwestern Region

AIR QUALITY
ATIKOKAN

ANNUAL REPORT, 1976

H. D. Griffin
Chief, Air Quality Assessment

TECHNICAL SUPPORT SECTION
NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

April, 1977

CONTENTS

SUMMARY

Ontario Ministry of the Environment has conducted an air quality assessment programme in the Atikokan area since 1971 and has coordinated sampling surveys conducted by two local iron ore mining companies since 1964.

Accumulation of a large air quality data base over many years permitted a reduction in the Ministry's activities in 1976. Vegetation and soil sampling was terminated, but snow sampling and air monitoring continued. Snow meltwater samples revealed excessive iron concentrations and moderately elevated arsenic levels in an area around the two mines, confirming results obtained from vegetation, soil and snow sampling in 1974 and 1975. The presence of iron and arsenic contamination was attributed to mining and ore processing operations.

Dustfall was somewhat lower in 1976 than earlier years and the average dustfall at six of eight locations was within the Ontario criterion. Suspended particulate concentrations were low.

Air monitoring carried out by a consulting firm for Ontario Hydro showed that nitrogen oxide levels did not exceed provincial criteria at three locations from June, 1975 to May, 1976. During the same period, only one value above the hourly criterion for sulphur dioxide was recorded at five sites. Most occurrences of measurable SO_2 were attributed to emissions from stacks at the ore pelletizing plants. At eight monitoring stations, sulphation rates were very low, thus confirming results from SO_2 measurements. Above criterion concentrations of ozone were frequently noted during summer months at two sites, but mining operations were not implicated as the cause.

INTRODUCTION

Air quality investigations have been undertaken in the Atikokan area for over a decade in connection with the operation of two iron ore mines and pelletizing plants. An earlier Ministry of Environment report (1) summarized results from vegetation and soil sampling, snow sampling and air monitoring surveys conducted during the period 1964 to 1974, and presented details of studies carried out in 1975.

Because of the accumulation of a large data base and the continuity of relatively unchanged emission levels from the two mining operations, the Ministry of Environment air assessment programme was further reduced in 1976. No vegetation or soil samples were collected, though snow sampling and monitoring of particulate contaminants continued. Continuous analysers to record levels of nitrogen oxides, ozone and sulphur dioxide were operated by a consultant firm on behalf of Ontario Hydro from mid 1975 to the spring of 1976.

VEGETATION AND SOIL ASSESSMENT

A number of vegetation and soil sampling surveys undertaken since mining operations began have shown that moderate amounts of arsenic and excessive quantities of iron have been deposited in the vicinity of the two pelletizing plants. Highest levels of both pollutants were recorded northeast of Caland Ore plant, but no visible adverse effects to local vegetation were observed.

Since an adequate data base on arsenic and iron levels in vegetation and soils had been established from many years of sampling, further work along these lines was discontinued in 1976. Vegetation surveys near an iron ore mining operation in northeastern Ontario had, however, revealed the occurrence of elevated fluoride levels in foliage of several plant species. Selected samples for 1975 from Atikokan were therefore re-submitted for fluoride analysis. Fluoride concentrations were found to be about 25 parts per million (ppm) in trembling aspen leaves 500 metres (m) northeast of Caland and about

3 ppm at the same distance and direction from the Steep Rock plant. The level of fluoride at a control site, 38 kilometres (km) east of Atikokan, was also 3 ppm. While fluoride concentrations near Caland were not considered excessive, some additional sampling is planned in 1977 to document the extent of contamination. Bentonite clay used as a binder in iron pellet formation is thought to be the most probable source of fluoride emissions.

SNOW SAMPLING

(a) Methods

One set of snow samples from 22 sites in the vicinity of the mines and at Atikokan was collected on March 15-16, 1976 (Figure 1). Control samples were obtained from two locations remote from the mines: one 38 km east and one 57 km east of Atikokan.

Sample points were selected in undisturbed snow, with preference for areas sufficiently open to permit the free fall of snow but not subject to excessive drifting. Areas judged to be affected by roads or other local sources of contamination were avoided. Each site was mapped, and information on site description, snow condition and snow depth was recorded. The nature and quantity of visible particulate contamination on and below the snow surface was also noted. Each sample comprised a surface area of about 50 by 50 centimetres (cm) and a depth of about 20 cm. Snow was collected with a clean plastic shovel, placed in large, heavy-gauge plastic bags, and retained in unmelted condition pending further processing. Samples were melted indoors in clean plastic pails pre-rinsed with distilled water. Measurements of pH were made as soon as melting was completed (about 12 to 18 hours). Meltwater was then vigorously stirred to suspend the particulate matter and decanted into clean, 1-litre plastic bottles for submission to the laboratory.

Atikokan samples were analysed for aluminum, arsenic and iron.

(b) Results

Chemical analysis results for snow meltwater are given in Table 1. Contaminant levels recorded in January, 1975, are also included for comparison. For both these surveys, the amount of fresh snow (that which fell during the 10-day period prior to sampling) was about the same. Aluminum concentrations in March, 1976, were rarely above background values. No gradient was evident with distance from either mine. Earlier surveys in 1974 and 1975 (2,3) had sometimes indicated a pattern of decreasing aluminum levels with increasing distance from source, but none of the concentrations recorded were ever considered excessive. No distribution pattern was apparent for arsenic in the 1976 samples, contrary to findings in former years. Iron, however, displayed well defined distribution gradients (Figure 2), similar in general location and area to those observed in 1974 and 1975. Levels of pH were fairly uniform throughout the survey area. Visible deposition of iron oxide dust on and below the snow surface was roughly the same in amount and extent in 1974, 1975 and 1976.

(c) Discussion

Snow sampling surveys are useful as indicators of the kind, amount and extent of contaminants in snow. Although elevated quantities of arsenic and iron have been found in snow near the Atikokan iron mines, the adverse environmental effects, if any, of the presence of these substances in snow cover has not yet been established.

Based on investigations in the vicinity of northern Ontario iron ore mines, guidelines have been established for arsenic and iron in snow meltwater. Concentrations above 0.05 milligrams per litre (mg/l) for arsenic and 5 mg/l for iron are considered excessive. Most of the iron levels in Atikokan snow were well above the meltwater guideline, except at locations more than 2 km from either pelletizing plant.

For arsenic, only 20 percent of values exceeded the guideline in 1976.

AIR MONITORING

(a) Particulate Pollutants

(i) Dustfall

Dustfall, one of the most visible classes of air pollutants, comprises particulate matter which settles out from the atmosphere under the influence of gravity. It is measured by exposing open-top vessels for 30 days and weighing the collected matter. Results are expressed in tons per square mile per month. The soluble and insoluble fraction of dustfall may also be analysed for specific substances, with results expressed in the same units used for total dustfall.

Figure 3 shows the dustfall (and sulphation) monitoring sites in operation in 1976. Monthly results are presented in Table 2, and annual mean dustfall is plotted in Figure 4. The data show that, in 1976, dustfall levels were generally acceptable at six of eight sites. Dustfall was lower at most stations in 1976 compared with both the preceding year and the average means for the period 1967 to 1975.

(ii) Suspended Particulate

Suspended particulate constitutes particulate matter of small size which remains in the atmosphere for extended periods. A measured volume of air is drawn through pre-weighed glass fibre filters for 24-hour periods every sixth day and the filters are then re-weighed to determine the quantity of dust collected. Results are expressed in micrograms per cubic metre of air ($\mu g/m^3$).

A record of suspended particulate values at station 62013 for 1976 is contained in Table 3, together with information on prevailing winds for the dates on which measurements were made. Only two of the 55 values exceeded the Ontario criterion of 120 $\mu g/m^3$. The geometric mean for the year was only 30 $\mu g/m^3$, well below the criterion of 60. Particulate concentrations were slightly higher with southerly prevailing winds than with winds from other directions. Values associated with easterly winds were lowest. Based on these data, the mining operations did not appear to contribute significantly to suspended particulate levels in the town of Atikokan.

(b) Gaseous Pollutants

As part of an environmental study for Ontario Hydro concerning a proposed thermal generating station at Marmion Lake, Acres Consulting Services Limited operated a network of air quality instruments from June, 1975 to May, 1976 (4). Their locations are shown in Figure 5. Sulphur dioxide was monitored at all five locations and nitrogen oxides and ozone were recorded at sites A, B and E.

(i) Nitrogen Oxides

The principal man-made sources of nitrogen oxides are fuel combustion in stationary sources and in vehicles. This class of pollutants is primarily important as a precursor to the formation of ozone and other oxidants.

A brief summary of data pertaining to nitrogen oxide is given in Table 4. Neither the hourly nor daily Ontario criterion was exceeded at any time. Higher than expected levels were occasionally recorded, but these were attributed to the operation of heating systems in nearby buildings, heat buildup in the instrument trailer causing instrument drift, or to the occasional emissions from nearby vehicles.

(ii) Ozone

Ozone and other oxidants are not primary pollutants emitted by industry and other man-made sources but are formed in polluted atmospheres as a result of a variety of photochemical reactions. Elevated ozone concentrations may have adverse effects on human health, vegetation and other materials.

Ozone levels in the Atikokan area (Table 4) exceeded Ontario's hourly criterion of 8 parts per hundred million (pphm) on a number of occasions, particularly during summer months in 1975. Reasons for these elevated concentrations have not been established, but natural phenomena have been suggested as a possible cause (4).

(iii) Sulphation Rates

Sulphation rate is measured by exposing lead dioxide-coated plates to the air for 30-day periods. Lead dioxide reacts with gaseous sulphur compounds in the atmosphere to form lead sulphate. The amount of sulphate formed is analytically determined and results reported as milligrams of sulphur trioxide per hundred square centimetres per day (mg SO_3/100 cm^2/day). Although several sulphur compounds may react with lead dioxide, sulphur dioxide is considered to be the only reactive pollutant in the Atikokan area.

Sulphation monitoring sites are shown in Figure 3 and results reported in Table 2. Values were very uniform throughout the survey area and the provincial criterion (0.70 mg/100 cm^2/day) was never exceeded. Levels were slightly higher in 1976 than 1975, but this may have been due to a slight alteration in the procedure for preparing the plates prior to exposure.

(iv) Sulphur Dioxide

Sulphur dioxide is one of the world's major atmospheric pollutants. Fuel combustion and industrial emissions are the principal sources. Many well documented adverse effects have been reported with respect to human health, vegetation and corrosion of building materials.

Sulphur dioxide concentrations monitored in 1975 and 1976 are summarized in Table 5. The hourly criterion of 25 pphm was exceeded only once (at site C) and the daily criterion not at all. Some 86 percent of the SO_2 readings occurred when monitors were downwind of the pelletizing plant stacks, thus implicating the latter as the prime emission sources. The generally very low levels encountered throughout most of the monitoring period agreed with low sulphation rates recorded at the same time.

ACKNOWLEDGEMENTS

Contributions and assistance from the following agencies is gratefully acknowledged:

- Steep Rock Iron Mines Limited and Caland Ore Limited for operation of the dustfall and sulphation monitoring network, for dustfall weight determinations and for assistance with snow sampling.
- Regional Laboratory, Northwestern Region, for chemical analysis of snow meltwater, and for dustfall and suspended particulate weight determinations.
- Atmospheric Environment Service, Environment Canada, Atikokan, for operation of a high volume air sampling unit.
- Air Quality Laboratory Section, Laboratory Services Branch, for preparation and analysis of sulphation plates.
- Inorganic Trace Contaminants Section, Laboratory Services Branch, for chemical analysis of snow meltwater.

REFERENCES

1. Griffin, H. D. (1976). Air Quality - Atikokan. Annual Report, 1975. Ontario Ministry of the Environment.
2. Griffin, H. D. (1974). Snow sampling study, Atikokan, 1974. Ontario Ministry of the Environment.
3. Griffin, H. D. and Racette, D. J. (1975). Snow sampling study, Atikokan, 1975. Ontario Ministry of the Environment.
4. Acres Consulting Services Limited. (1976). Marmion Lake environmental studies.

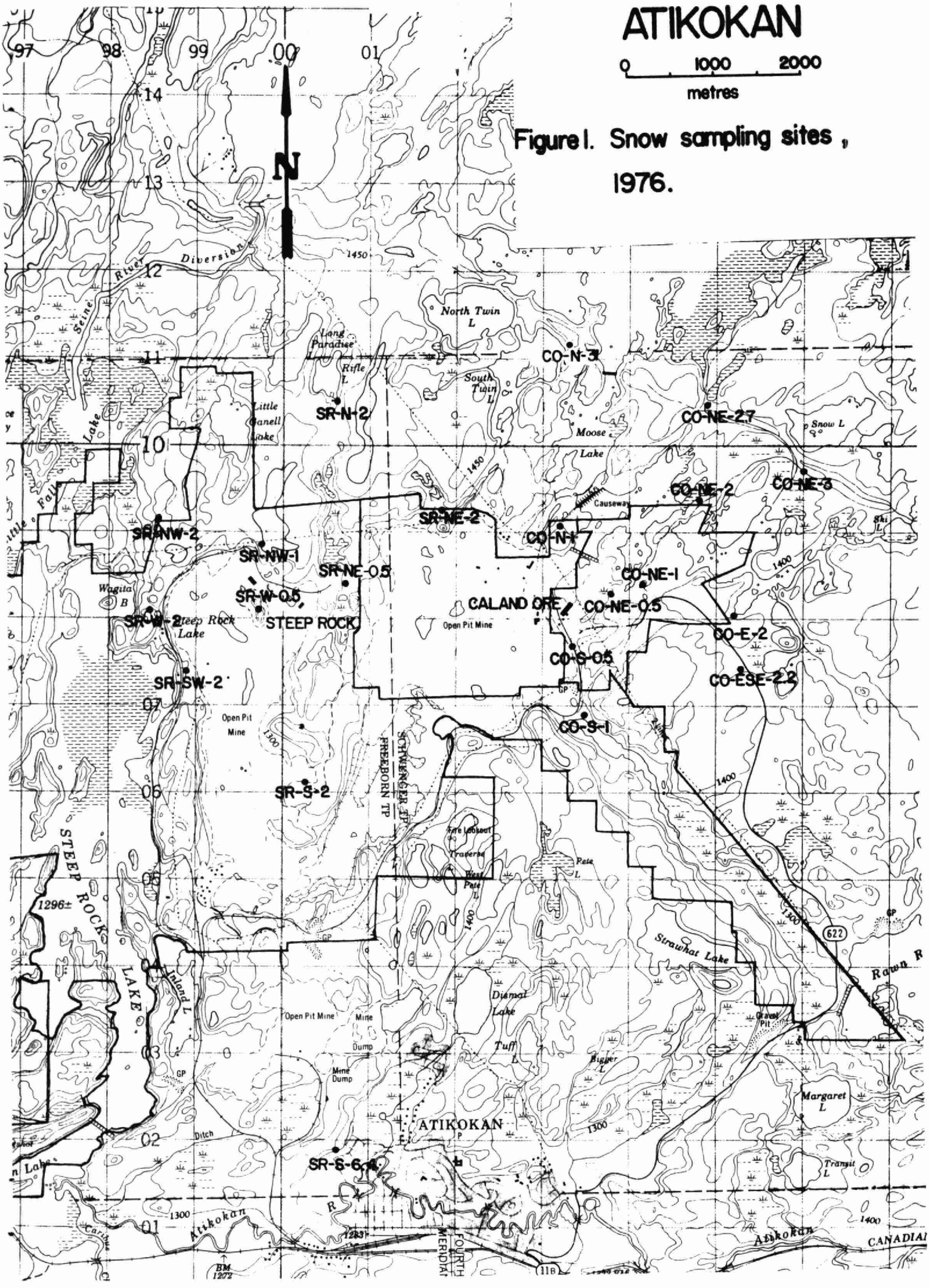

Figure 1. Snow sampling sites, 1976.

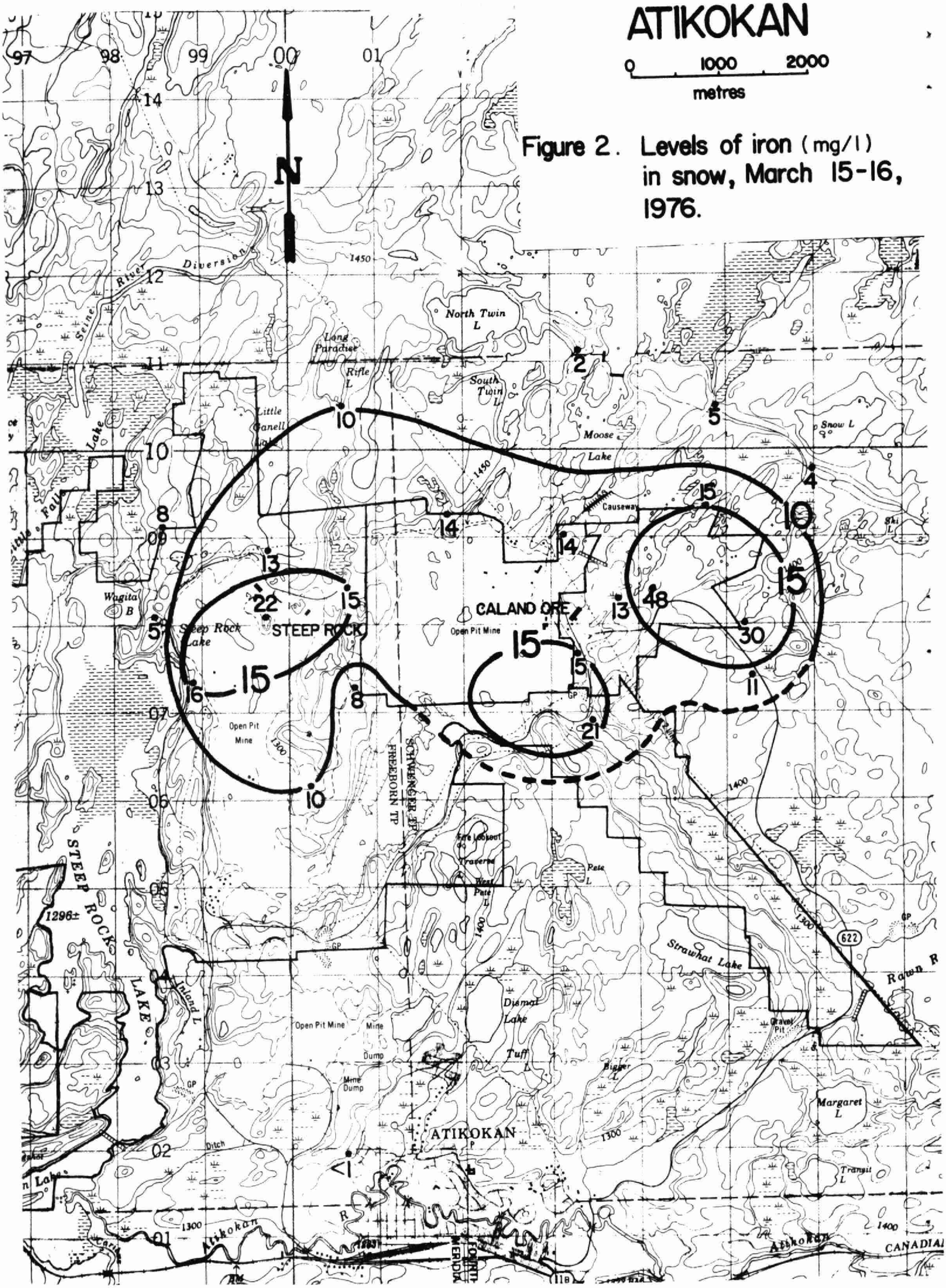

Figure 2. Levels of iron (mg/l) in snow, March 15-16, 1976.

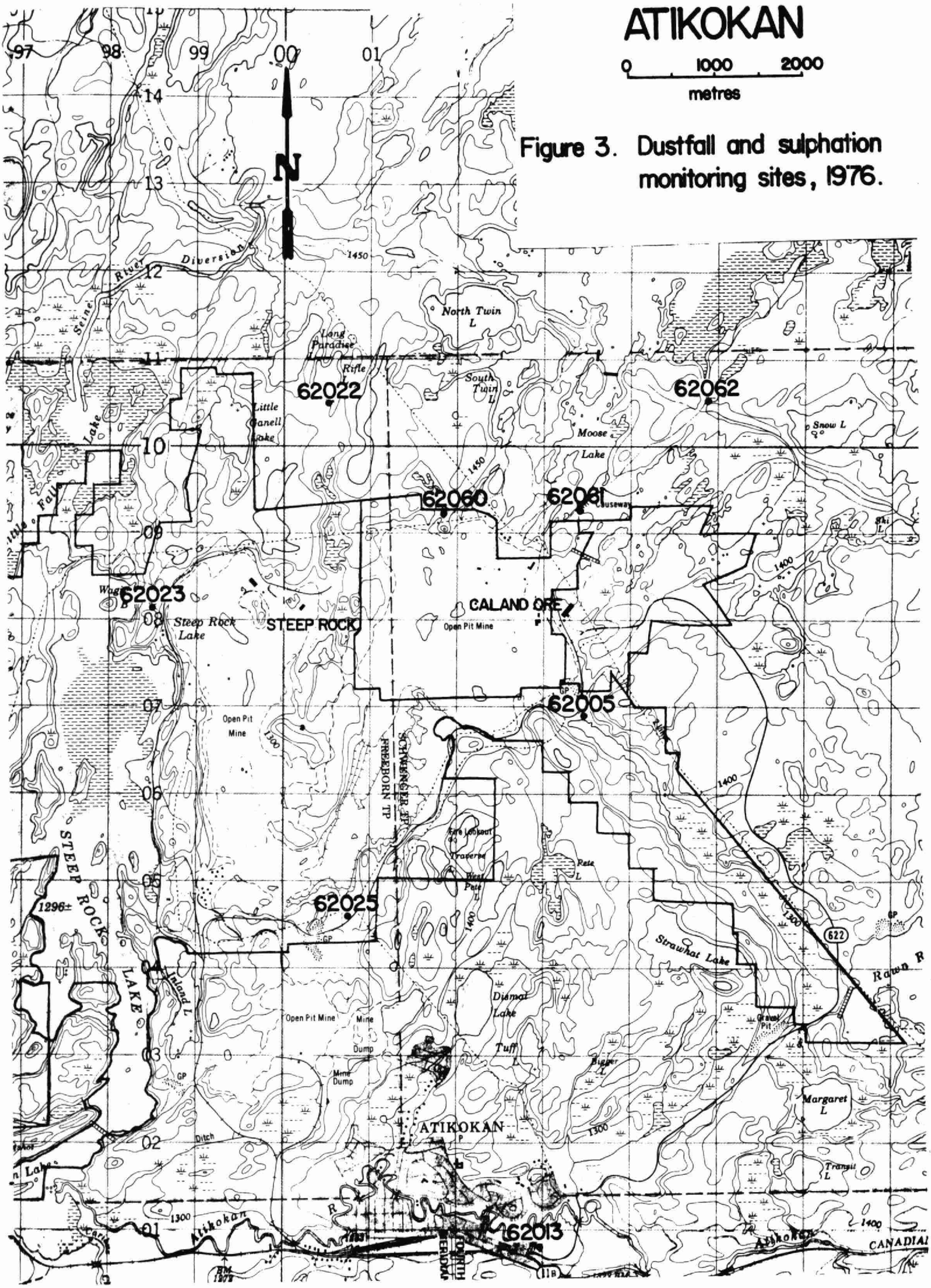

Figure 3. Dustfall and sulphation monitoring sites, 1976.

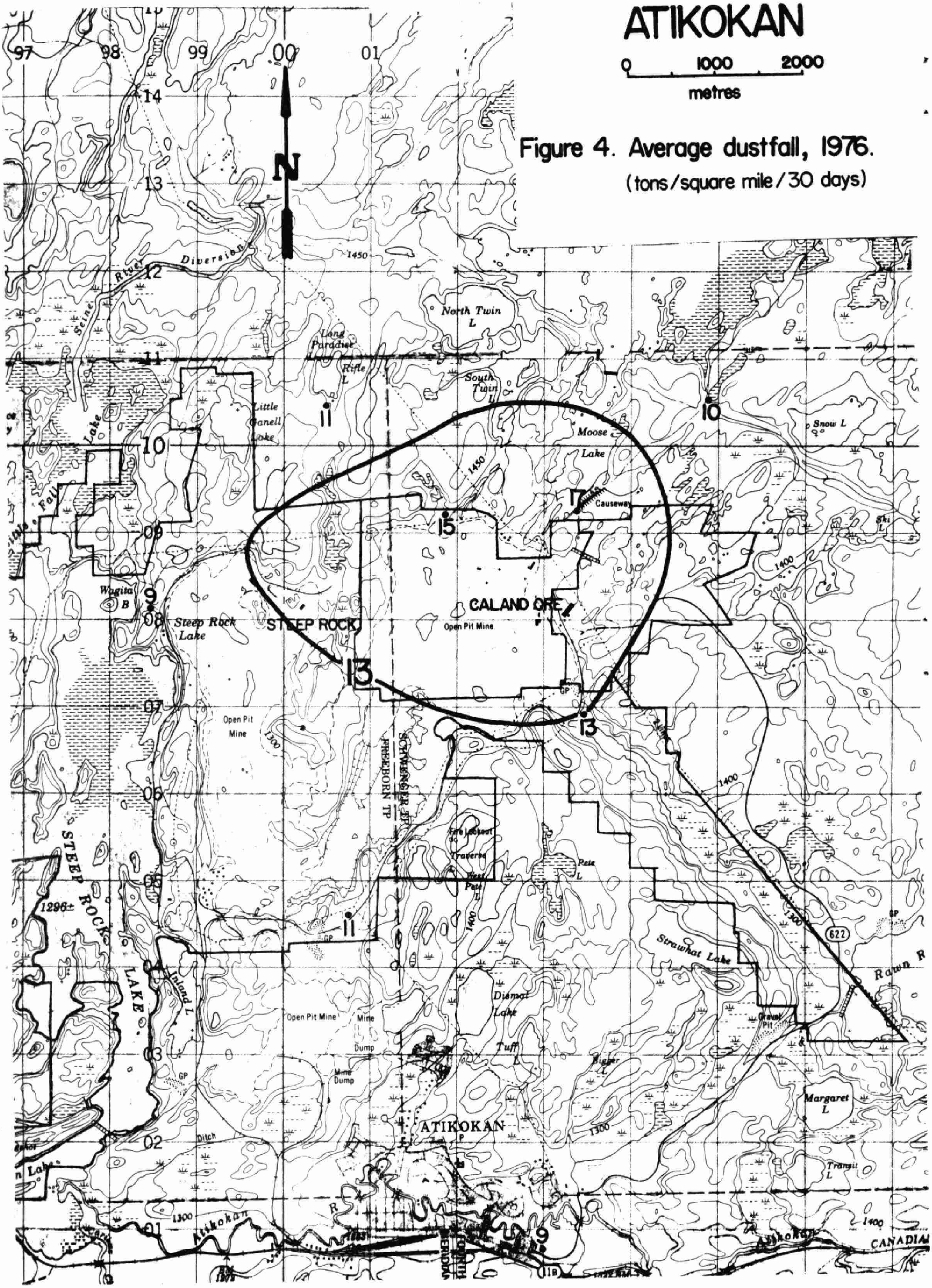

Figure 4. Average dustfall, 1976. (tons/square mile/30 days)

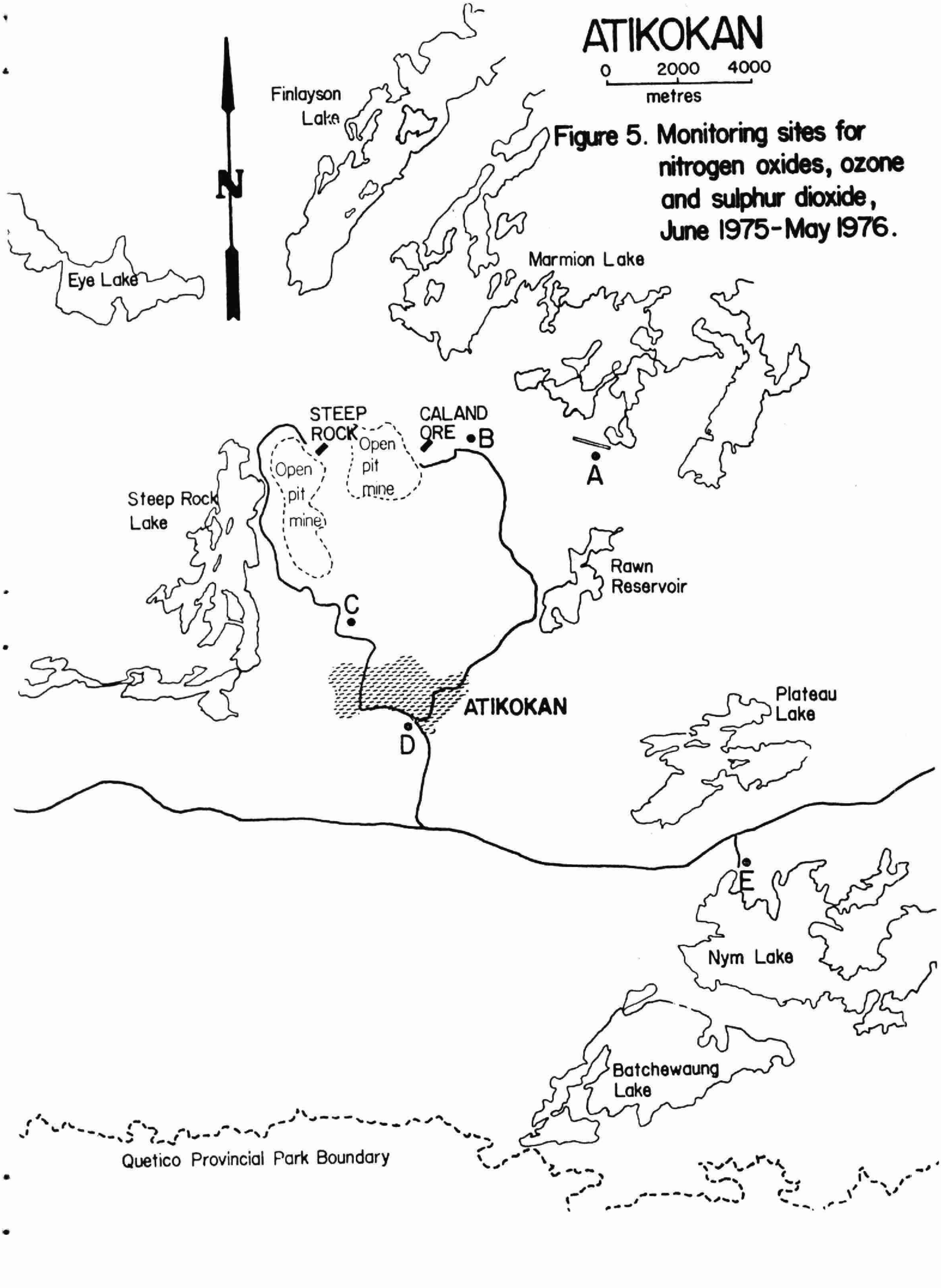

Figure 5. Monitoring sites for nitrogen oxides, ozone and sulphur dioxide, June 1975-May 1976.

TABLE 1. Levels of aluminum, arsenic, iron (all in mg/l) and pH in snow collected near Atikokan iron ore plants, January, 1975, and March, 1976.

Distance (km) and direction from source*	Aluminum		Arsenic		Iron		pH
	1975	1976	1975	1976	1975	1976	1976
CO-N-1.0	< 0.1	0.2	0.02	< 0.01	15	14	4.9
CO-N-3.0	< 0.1	0.2	0.06	< 0.01	3	2	3.9
CO-NE-0.5	< 0.1	0.2	0.21	< 0.01	26	13	3.9
CO-NE-1.0	< 0.1	1.5	0.06	0.10	64	48	4.0
CO-NE-2.0	< 0.1	0.3	0.03	0.03	11	15	3.8
CO-NE-2.7	-	0.3	-	< 0.01	-	5	3.8
CO-NE-3.0	0.4	0.3	0.10	0.12	6	4	3.8
CO-E-2.0	< 0.1	0.6	0.10	0.05	11	30	3.9
CO-ESE-2.2	-	0.2	-	< 0.01	-	11	3.7
CO-S-0.5	< 0.1	0.2	0.10	0.03	20	15	4.5
CO-S-1.0	< 0.1	0.2	0.03	0.03	7	21	4.1
SR-S-1.0	-	0.3	-	0.02	-	8	4.3
SR-S-2.0	< 0.1	0.6	0.02	< 0.01	4	10	4.9
SR-S-6.4	< 0.1	3.0	0.02	< 0.01	1	< 1	3.7
SR-SW-2.0	< 0.1	0.6	0.03	0.07	4	16	4.9
SR-W-0.5	< 0.1	0.5	0.08	< 0.01	6	22	5.5
SR-W-2.0	0.4	0.2	0.07	< 0.01	6	5	4.2
SR-NW-1.0	< 0.1	0.5	0.11	< 0.01	19	13	5.4
SR-NW-2.0	< 0.1	0.3	0.03	< 0.01	1	8	4.8
SR-N-2.0	0.1	0.1	0.05	< 0.01	6	10	3.8
SR-NE-0.5	-	0.3	-	0.06	-	15	4.1
SR-NE-2.0	< 0.1	0.5	0.07	< 0.01	14	14	4.5
Control 1	< 0.1	0.2	-	< 0.01	< 1	< 1	3.6
Control 2	0.2	0.3	< 0.01	< 0.01	< 1	< 1	3.6

*Location cited with reference to direction and distance (km) from Caland Ore (CO) and Steep Rock (SR) pelletizing plants.

TABLE 2. Dustfall and sulphation, Atikokan, 1976.

Station	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
		Dustfall (tons/square mile/30 days)*												
62005	Fairweather	9	7	16	11	15	15	-	16	19	22	5	5	13
62013	Atikokan	2	3	8	5	15	15	9	13	14	17	4	3	9
62022	Mary Lake	5	9	9	11	9	13	11	16	15	16	14	2	11
62023	Water Tower	7	11	11	12	8	15	6	11	8	12	5	1	9
62025	Pal Lake Road	6	7	7	11	10	11	16	14	14	23	8	3	11
62060	Lime Point	10	11	20	13	19	19	15	18	19	20	6	9	15
62061	Moose Lake Dam	8	3	14	8	29	29	14	27	27	28	5	7	17
62062	Mando Road Dump	5	20	9	6	13	13	9	-	-	-	-	5	10
		*Values exceeding criteria of 20 (monthly) or 13 (annual average) are underlined.												
		Sulphation rate (mg SO_3/100 cm^2/day)												
62005	Fairweather	.07	.04	.06	.10	.03$^+$	.03$^+$	.05	.05	.06	.06	.06	.06	.06
62013	Atikokan	.07	.04	-	.10	.03$^+$	.03$^+$	.05	.06	.03	.07	.07	.06	.06
62022	Mary Lake	.09	.09	.06	.06	.06	.06	.04	.05	< .03	.10	.08	.09	.07
62023	Water Tower	.06	.08	.10	.06	.04	.08	.04	< .03	< .03	.06	.04	.06	.06
62025	Pal Lake Road	.06	-	.06	.06	.06	.06	< .03	.03	-	.06	.04	.06	.05
62060	Lime Point	-	.10	.04	.13	< .03$^+$	< .03$^+$	< .03	.05	.03	.06	.05	.05	.05
62061	Moose Lake Dam	-	.11	.08	.10	.05$^+$	.05$^+$	.05	.05	.05	.06	.06	.06	.07
62063	Nym Lake							.03	-	.07	-			

$^+$exposed for two months (May-June)

TABLE 3. Suspended particulate levels (µg/m^3), station 62013, Atikokan, 1976.

Date		µg/m^3	Wind*
January	1	8	E 4
	7	20	W 12
	13	-	
	19	-	
	25	20	SVL+ 1
	31	14	WNW 11
February	6	9	W 12
	12	22	NW 8
	18	12	N 5
	24	62	W 3
March	1	17	E 7
	7	11	WNW 15
	13	12	SSE 8
	19	18	ESE 5
	25	12	ESE 9
	31	54	N 10
April	6	58	SVL 6
	12	57	WSW 5
	18	17	WSW 9
	24	-	
	30	43	NW 10
May	6	33	WNW 9
	12	37	SVL 5
	18	65	SVL 3
	24	58	NE 4
	30	-	
June	5	121**	SSW 7
	11	28	ESE 11
	17	18	SVL 5
	23	55	SVL 7
	29	28	NE 6
July	5	26	SSW 6
	11	26	NNW 12
	17	28	WNW 8
	23	28	W 10
	29	30	SVL 3
August	4	23	SW 6
	10	34	WSW 6
	16	41	SVL 3
	22	26	NNW 5
	28	-	
September	3	64	SVL 19
	9	53	WNW 6
	15	37	SVL 4
	21	26	SVL 9
	27	36	W 5
October	3	64	SE 12
	9	49	WNW 1
	15	42	N 14
	21	11	WNW 12
	27	43	SW 10
November	2	122	W 18
	8	49	SSE 7
	14	85	W 6
	20	16	E 3
	26	-	
December	2	46	SVL 1
	8	27	W 4
	14	15	WNW 20
	20	38	NNW 12
	26	8	W 5

*Prevailing direction and speed (kilometres per hour).

+SVL = several

**Values above Ontario criterion of 120 µg/m^3 are underlined.

TABLE 4. Maximum hourly, daily and mean monthly nitrogen oxide and ozone concentrations (parts per hundred million), Atikokan, June 1975 to May 1976.

Site	Averaging period	1975 Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May
		Nitrogen oxides											
A	1 hour	1	1	1	1	-	-	2	5	5	10	7	3
	24 hours	1	1	1	0	-	-	1	1	2	10	3	2
E	1 hour	1	4	5	10	-	-	-	0	4	2		
	24 hours	1	2	2	3	-	-	-	0	1	1		
B	1 hour											10	2
	24 hours											3	1
		Ozone											
A	1 hour	7	10	9	10	10	5	-	5	6	7	9	6
	24 hours	7	9	7	7	6	4	-	4	5	6	7	5
	1 month	4	4	4	4	3	3	-	4	4	5	5	5
	no. above criterion*	0	35	6	21	5	0	-	0	0	0	7	0
E	1 hour	9	10	9	9	9	5	4	4	5	6		
	24 hours	7	8	7	6	6	4	4	4	4	5		
	1 month	5	4	3	3	3	3	3	3	4	4		
	no. above criterion	1	21	4	1	3	0	0	0	0	0		
B	1 hour											8	6
	24 hours											6	5
	1 month											4	4
	no. above criterion											0	0

*Number of hourly readings exceeding Ontario criterion of 8 parts per hundred million.

TABLE 5. Maximum hourly, daily and mean monthly sulphur dioxide concentrations (parts per hundred million), Atikokan, June 1975 to May 1976.

Site	Averaging period	1975 Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May
A	1 hour	0	0	0	4	2	0	12	8	7	2	2	0
	24 hours	0	0	0	0	1	0	1	1	2	1	0	0
	1 month	0	0	0	0	0	0	0	0	0	0	0	0
B	1 hour	0	0	1	3	4	2	8	7	9	3	0	0
	24 hours	0	0	0	1	1	1	1	2	2	0	0	0
	1 month	0	0	0	0	0	0	0	0	0	0	0	0
C	1 hour	0	0	0	54	3	1	8	6	0	6	3	3
	24 hours	0	0	0	4	1	0	1	1	0	1	0	1
	1 month	0	0	0	0	0	0	0	0	0	0	0	0
D	1 hour	0	7	0	3	2	2	-	4	4	0	2	2
	24 hours	0	0	0	0	0	0	-	1	1	0	0	0
	1 month	0	0	0	0	0	0	-	0	0	0	0	0
E	1 hour	2	0	0	0	1	2	2	1	0	2	1	1
	24 hours	0	0	0	0	0	1	0	0	0	0	0	0
	1 month	0	0	0	0	0	0	0	0	0	0	0	0